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ABSTRACT

This study compared the performance of 59 black students and 32 white students on tasks requiring formal operations. The study compared groups from different racial backgrounds and similar socioeconomic environments. It was assumed that if socioeconomic difference was a more weighty experience factor than was racial difference, then differences in performance on the formal operations tasks should be minimal. It was also assumed that the racial designation of students was not a sufficient experience factor to cause important differences of performance on formal operations tasks. A 2,000 student comprehensive high school in a large midwestern city was selected as the setting for the study because it was racially mixed and because few of the students were on welfare. This suggested (along with sociogeographic data) that both the white and black students were of equivalent socioeconomic status. Formal operations problems included combinations, exclusions, and proportions. Raven's Advanced Progressive Matrices were also administered. The only significant differences in scores between the two groups appeared on the combination problems. It was concluded that at the formal operational level of cognitive processing, differences of performance cannot be attributed only to racial heritage. Experience does affect cognitive processing, but, since cultures here are only identified by racial designations and do not consist of racial differences, the important experiences are not racial. (Author/AM)

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Black and White High School Students' Performance on Formal Operations Tasks

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Although much of the empirical work done with regard to Jean Piaget's theory of intellectual development has concerned younger children, and especially the phenomenon of conservation, of equal importance is the period of formal operations. It is at this older age-level that differences in performance due to culture can be expected to emerge. Many investigators (e.g., Lovell, 1971; Goodnow, 1970; Vernon, 1969) have found such differences on formal operations tasks. Piaget himself (1972) recognizes that experience will result in increasing differentiation of performance as age increases. The longer cultural differences have to make an effect, the greater that effect will be.

This study intended to compare the performance of black students and white students on tasks requiring formal operations. If a difference between these cultural groups exists, it could be due to the effect of race, to culture, to the effect of socio-economic conditions, or to an interaction. The two groups to be compared could have been chosen for the likelihood of maximum differences, in which case street culture black students could have been compared to suburban-mainstream culture whites. Maximizing the cultural difference would have led to a prediction of differences of performance on the formal operations tasks. The difficulty would be that such differences could have been attributed to either racial background or to socio-economic class difference.

An alternative approach, chosen for this study, would be to compare groups from different racial backgrounds, but with similar socio-economic environments. If socio-economic difference is a more weighty experience factor than is racial difference, then differences in performance on the formal operations tasks should be minimal. Insofar as possible, this study attempts to demonstrate that the racial designation of students is not a sufficient experience factor to cause important differences of performance on formal operations tasks.

Method

Subjects

Two events have increased the difficulty of obtaining a truly random selection of subjects, especially in such an emotionally sensitive area as racial differences. The Family Education Rights and Privacy Act of 1974 has made school administrators sensitive to subject selection, and the APA ethical standards have made investigators sensitive to the need to obtain parental permission for minors. This study conformed to both standards, with the result that no information could be obtained from existing student files. This meant that no matching for intelligence or achievement could be done within existing time and finanical constraints. Also, the sample was biased in the sense that all subjects agreed to participate both as individuals and through parental permission. This suggests biases of motivation and attitude, although there is no empirical confirmation.

A 2,000 student comprehensive high school in a large, mid-western city was selected as a population because it was racially mixed and because few of the students were on welfare. This suggested (as did existing socio-geographic data) that both the white and black students were of equivalent socio-economic status. The black families in the area are upwardly-mobile, and typically have one or both parents working. It was felt that cognitive processes are more highly influenced by the attitudes and living patterns associated with socio-economic status than with those associated with racial heritage, and that equality of performance would result if there were socio-economic similarity even if racial difference prevailed.

One of the school administrators selected both individuals and classes in the following manner. Individuals were selected randomly from lists of students by grade level. Classes were selected with the controlling principle that no class was chosen which had an obvious bias in the type of student who could be expected to be enrolled in it; e.g. advanced mathematics was not selected, heterogeneously grouped English was chosen. The students were told they would do some problems and

the results would not become a part of their academic record. Each student volunteered for participation by returning (or not returning) the parental consent form on the next class day. The only reward given to participants was to be excused from one class for one day. A total of 91 students, 59 black and 32 white, were tested.

An indication of general cognitive skill was obtained by administering the Raven's Advanced Progressive Matrices (1965). Since the students were available for only one hour of testing, the ten item Set I was used instead of the longer Set II. There was no significant difference between the black and white students. The groups showed no significant difference in age (16.5 yrs., S.D. = 1.3 yrs.), or sex (45 male, 46 females). Neither was grade level significantly different for the two groups, (9th=29, 10th=20, 11th=22, 12th=20). A check was made for experience in terms of mathematics classes which might have formally discussed proportion or correlation. No significant difference was found for numbers of black and white students who had taken (or were taking) General Math (55 yes), Algebra (70 yes), Geometry (51 yes), or Computer Math (4 yes).

Materials

There were two constraints on the testing tasks: one, that it be possible to do group testing; two, that the items be less formal and academically-oriented than those typically used for the testing of formal operations in order to eliminate to some extent the white advantage when dealing with school-like tasks.

Gray (1973) had developed a written test for formal operations, and these tasks served as a model. They were revised in terms of language but not in terms of logic. That is, Gray had shown how his tasks required the formal operational structures of Proportion, Exclusion, and Combination as elaborated by Inhelder and Piaget (1958). As holds true for the whole of Piagetian theory, content may---and will---vary, but the underlying logical process remains the same. It is not which problem is solved, but the type of logic necessary for solution which is

the important factor. Thus, no hazard was presented to Gray's test-construction by changing the language of the tasks, since the logic required for solution was not changed. In general, the language was simplified and vocabulary kept to words typically found in spoken communication rather than coming from more formalized written style. Situations and personal names were revised so as to be more appropriate to city dwelling than to middle-class suburban experience.

There were six items in each of the three categories. The Proportion items were of two types. First, there were two spatial items requiring the completion of a two-dimensional matrix of figures. Second, there were four items which tested various degrees of understanding of correlation between two co-existing variables. The Exclusion items were also of two types. First, there were two items involving coordination of two descriptive series so as to eliminate irrelevant information. Second, there were four items requiring exclusion of irrelevant information from a series of logically related statements. The six Combination items involved the production of all possible combinations of individual cases varying in degree of complexity. Each set of items had two problems representing late concrete operations and two each representing early and late formal operations.

Procedure

The items were arranged in booklets preceded by a sheet of instructions and some examples. Items for each type of problem remained in the same order within all booklets, but the four types of problems (Combinations, Exclusion, Proportion, Raven's) were randomly varied in order. Subjects wrote their answers directly on the booklets, and were allowed to make any other written notations they wished.

There were two black proctors and two white proctors, each with responsibility for eight subjects at a testing session. No significant difference was found in terms of race of the proctor.

Results

The three sets of Piagetian tasks were scored on a right or wrong basis

with no provision for partial credit. Problems not attempted were scored as if wrong. The two groups showed no significant difference for the Proportion and Exclusion problems, but did show a significant difference for the Combination problems (see Table 1.)

Insert Table 1 about here

Further analysis was done by using the Multiple Hierarchical Analysis (MHA) technique devised by Hofmann and Gray (1975). By utilizing item difficulty and scale reproducibility data, it allows for an examination of the scalability of the tasks. That is, to what extent the tasks are truly representative of a hierarchy of less-to-more difficult. It is of interest to note differences between the racial groups in the scalability of the tasks (see Table 2).

Insert Table 2 about here

For the Proportion set, item 1 was more difficult for the black students than for the white students. It was a pictorial item requiring the completion of a matrix of domino-like objects which changed across two dimensions. Although items 4 and 5 were reversed in difficulty for the two groups, their similarity of difficulty suggests that this was an unimportant difference. The scales differed somewhat in structure because of item 1, but the reproducibility indices were nearly identical.

The Exclusion problems showed virtually identical performance for the two groups. Item difficulties and the reproducibility structures were not different in any significant ways.

For the Combination problems, there are no important differences in the structure of the scales (The reversal of items 1 and 2 is unimportant because they represent the same level of development.); the reproducibility indices are both extremely high. But the proportion of black students correctly solving item 3 and 4 was much lower than the proportion of white students. These two

problems involved the construction of all possible combinations of pairs from lists of six or seven persons.

Discussion

The only significant difference in scores between the two groups was for the Combination problems. Examination of the item difficulties for these problems suggests that two of them (3 and 4) were primarily responsible. Several alternate explanations exist. One possibility would be that language problems interfered with the performance of the black students, but this can be rejected because these two problems involved making lists of names and there was no need to generate sentences or statements. Another possibility, which cannot be rejected, is that a true difference in cognitive processing exists. This seems unlikely because of the restricted and specialized nature of the performance difference. That is, if a difference of processing truly existed, it would appear in other problems as well as the two Combination ones.

A third possibility has the advantage of also applying to the difference of performance noted for Proportion item 1. The performance difference may be largely a motivational one. The three items demonstrating differences (Proportion 1, Combination 3 and 4) all involve "busy-work"; that is, they all require an extended set of essentially repetitious performances. It is possible, indeed likely, that black students were less interested in completing these tasks because of their repetitiveness. A weakness of this explanation is that other tasks were equally "dull" or repetitive, but they did not elicit the same disparity in performance. This study does not provide the answer concerning the adequacy of the competing explanations.

This study demonstrates that at the formal operational level of cognitive processing, differences of performance cannot simply be attributed to racial heritage. Experience, including a myriad of cultural and socio-economic influences, does affect cognitive processing; but, since cultures are only

identified by racial designations and do not consist of racial differences, the important experiences are not racial.

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Table 1

Comparison of Black and White Students

on Three Types of Formal Operations Tasks

	Black Students (N = 59)		White Students (N = 32)		t (df = 89)	
	M	SD	M	SD		
Proportion	3.576	1.567	3.750	1.524	.510	n.s.
Exclusion	2.237	1.406	2.375	1.454	.441	n.s.
Combination	2.695	1.429	3.719	1.301	3.365	$p<.01$

Table 2

Item Difficulties and Scale Reproducibilities for Black and White Students on Three Sets of Formal Operations Tasks

	Black (N = 59)		White (N = 32)	
Proportion	Item	Difficulty	Item	Difficulty
	3	.77	2	.84
	2	.73	1	.84
	1	.63	3	.69
	5	.47	4	.53
	4	.45	5	.50
	6	.45	6	.34
Reproducibility Index		.90		.87
Exclusion	2	.78	2	.84
	1	.65	1	.72
	4	.38	4	.41
	3	.22	3	.16
	6	.10	6	.13
	5	.07	5	.06
Reproducibility Index		.95		.97
Combination	1	.85	2	1.00
	2	.82	1	.97
	3	.43	3	.75
	4	.37	4	.69
	6	.15	6	.19
	5	.05	5	.16
Reproducibility Index		.96		.99